Session V.   TDWR Data Link / Display

N91-24177

Orlando Experiment
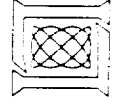Dr. Steve Campbell, MIT Lincoln Laboratory

ORLANDO '90

FAA TERMINAL DOPPLER WEATHER RADAR PROGRAM

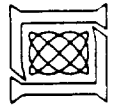## NASA/FAA AIRBORNE WIND SHEAR PROGRAM

STEVEN D. CAMPBELL

M. I. T. LINCOLN LABORATORY

17 OCTOBER 90

TOPICS

- TDWR TESTBED RADAR PERFORMANCE

- COCKPIT DISPLAY SYSTEM

- FLIGHT OPERATIONS

- ANALYSIS WORKSTATION

- FUTURE WORK

WINDSHEAR DETECTION
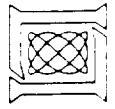RADAR LOCATIONS FOR
1990 TESTS IN ORLANDO

UND

FL-3

FL-2

1 MILE

MICROBURST RECOGNITION

	POD	PFA
TDWR spec.	≥ 90%	≤ 10%
Denver '88	90%	5%
KC '89	96%	7%
Orlando '90	95%	4%

MICROBURST

MODE: MAINTENANCE
OPTION:

GF MOVEMENT: AIRPORT
ARCHIVE: READY 12 HRS REMAIN
AUDIBLE: OFF   RANGE: 5NM
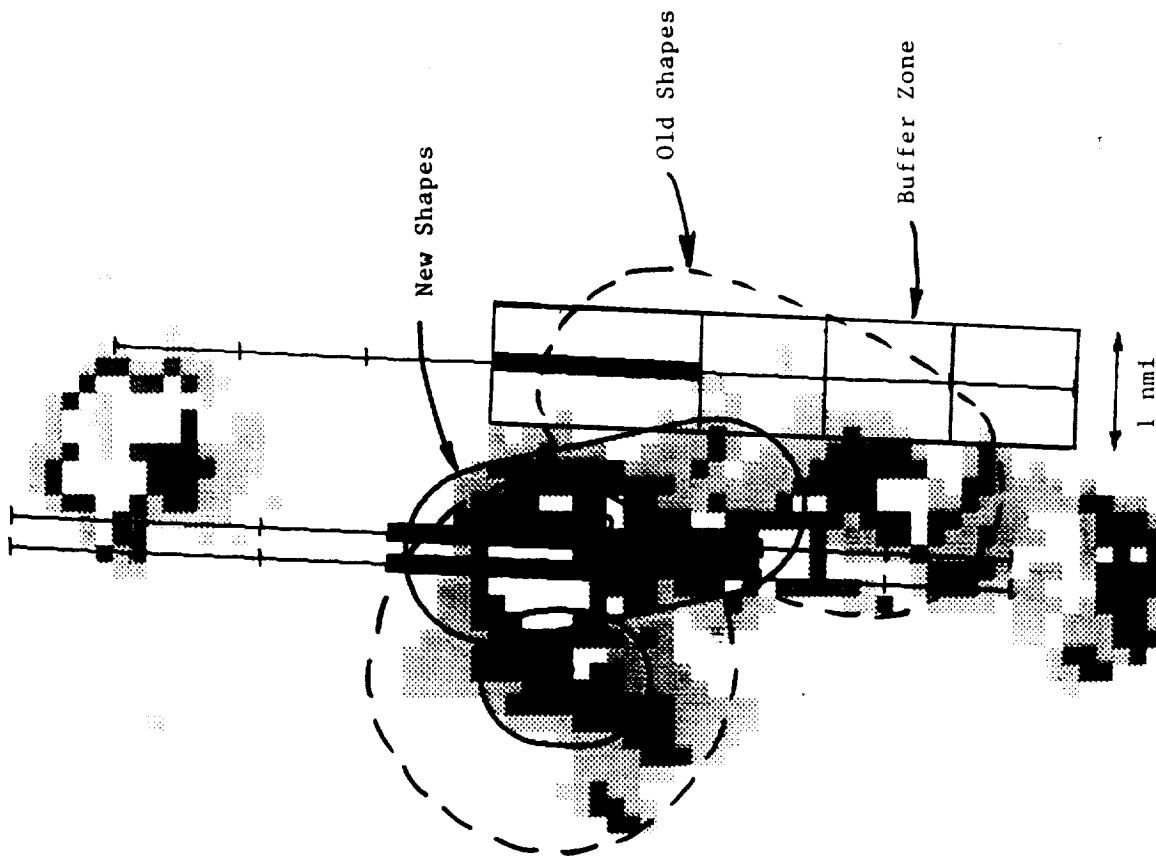STORM MOTION: ON   MB PREDICT: ON
PRECIP: 3 4

17A	WSA 25k-	RWY	Calm
17D	WSA 25k-	RWY	Calm
35A	WSA 25k-	1WF	Calm
35D	WSA 25k-	RWY	Calm
18LA	WSA 25k-	RWY	030 05
18LD	WSA 25k-	RWY	340 04
36RA	WSA 25k-	2WF	340 04
36RD	WSA 25k-	RWY	030 05
18RA	WSA 25k-	RWY	030 05
18RD	WSA 25k-	RWY	340 04
36LA	WSA 25k-	2WF	340 04
36LD	WSA 25k-	RWY	030 05

OVERLAY   RUNWAY   CLEAR

PARAMETER ADJUSTMENT

New Shapes

Old Shapes

Buffer Zone

1 nm1

BUFFER ZONE ADJUSTMENT

8 JUL 90 19:57:26

MICROBURST

MODE: MAINTENANCE
OPTION:

GF MOVEMENT: AIRPORT
ARCHIVE: READY 12 HRS REMAIN
AUDIBLE: OFF
STORM MOTION: ON   MB PREDICT: ON
RANGE: 5NM
PRECIP: 3 4

17A	340 04		
17D	030 03		
35A	050 03		
35D	340 04		
18LA	WSA 25k-	RWY	Calm
18LD	WSA 25k-	RWY	030 05
36RA	WSA 25k-	2WF	030 05
36RD	WSA 25k-	RWY	Calm
18RA	WSA 25k-	RWY	Calm
18RD	WSA 25k-	RWY	030 05
36LA	WSA 25k-	2WF	030 05
36LD	WSA 25k-	RWY	Calm

BUFFER ZONE

0.5 nmi

OVERLAY   RUNWAY   CLEAR

MICROBURST PREDICTION

	POD (≥15 m/s)	PFA (< 10 m/s)	Warning (min.)
KC '89	61%	11%	5.0
Orlando '90	56%	7%	6.4
Mean	59%	9%	5.7

250

(a)

Microburst
Prediction

20

1843 (UT)
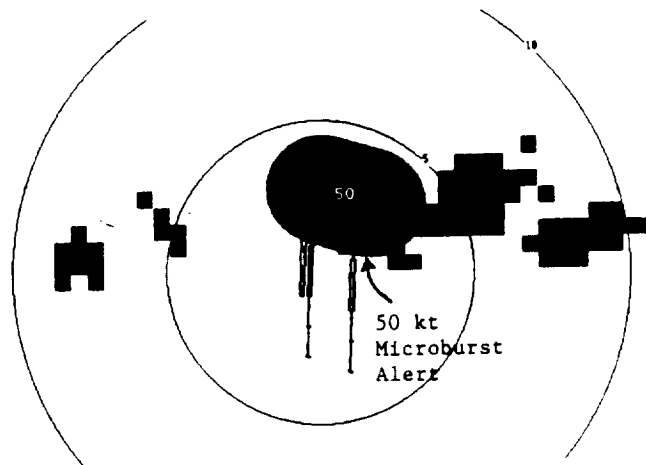
(b)

20 kt
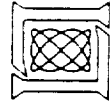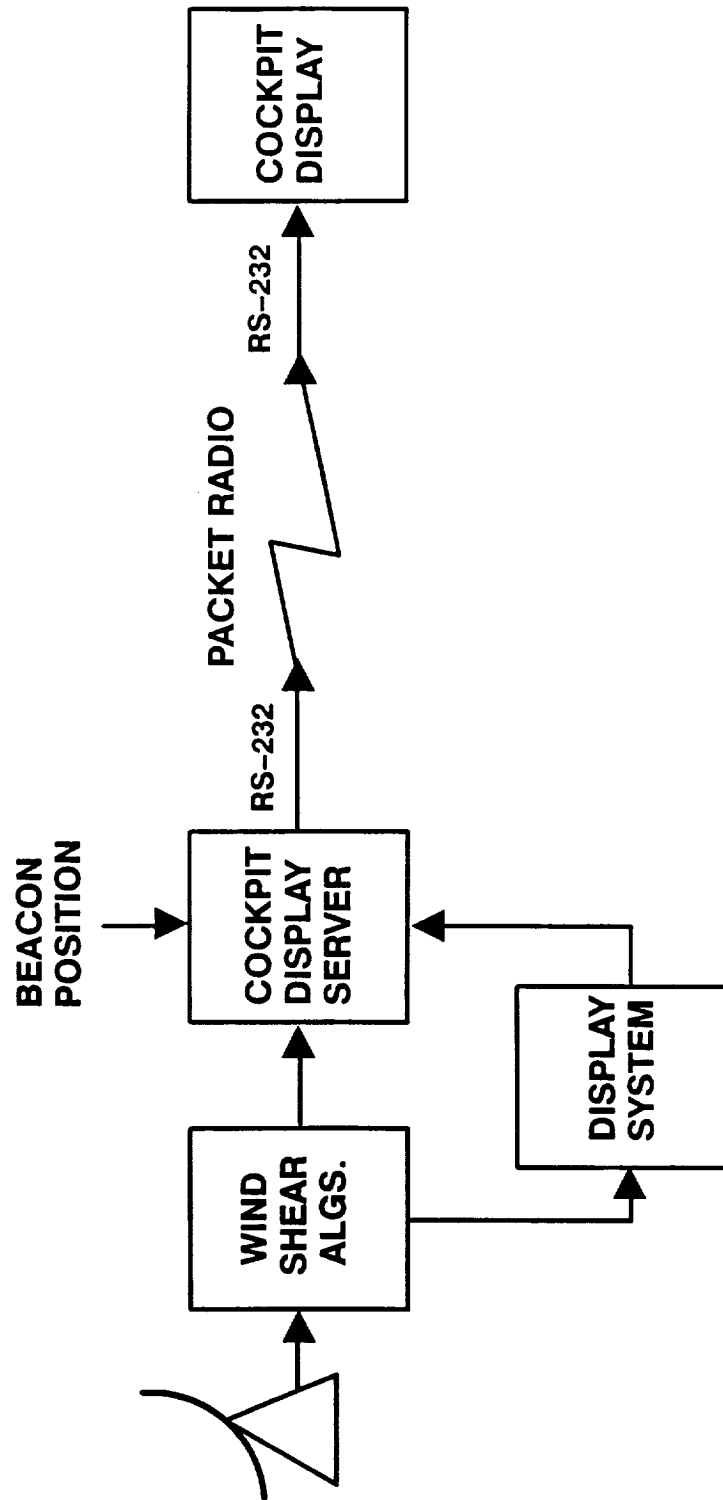Microburst
Alert

1850 (UT)

(c)

50

50 kt
Microburst
Alert
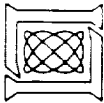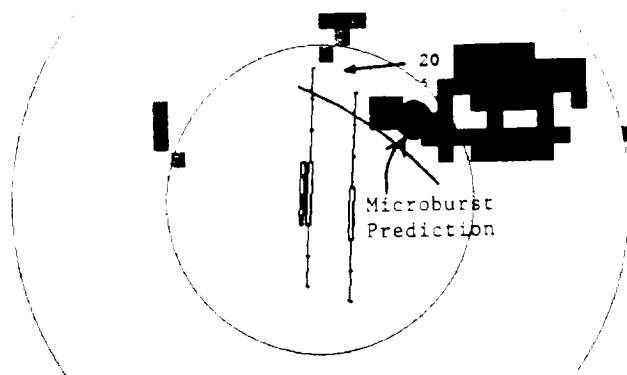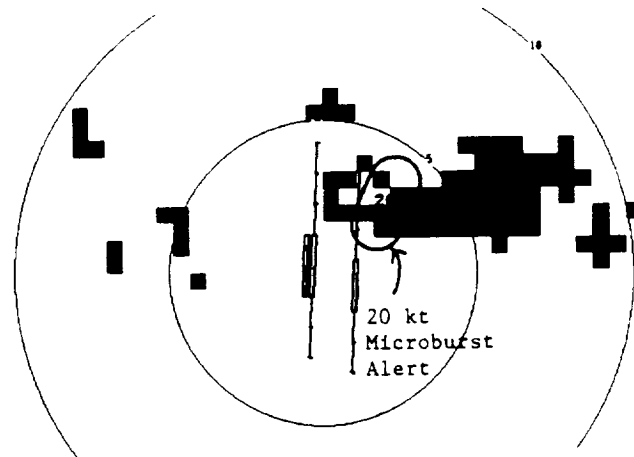
1855 (UT)

Figure 1. Microburst prediction example for July 7, 1990

COCKPIT DISPLAY SYSTEM

TDWR TESTBED RADAR

CITATION AIRCRAFT

BEACON
POSITION

COCKPIT
DISPLAY
SERVER

RS-232

PACKET RADIO

RS-232

COCKPIT
DISPLAY

WIND
SHEAR
ALGS.

DISPLAY
SYSTEM

252

COCKPIT WIND SHEAR DISPLAY

(MODIFIED ARGUS 5000)

10 nmi (20 km)

← 1.7" →

15

Gust Front

Microburst
Prediction

5m

19

• ARP

1

20   Wind Shear
      with Loss

40

Microburst
Alert

Own Aircraft

DEP

ENR

ARR

AUX

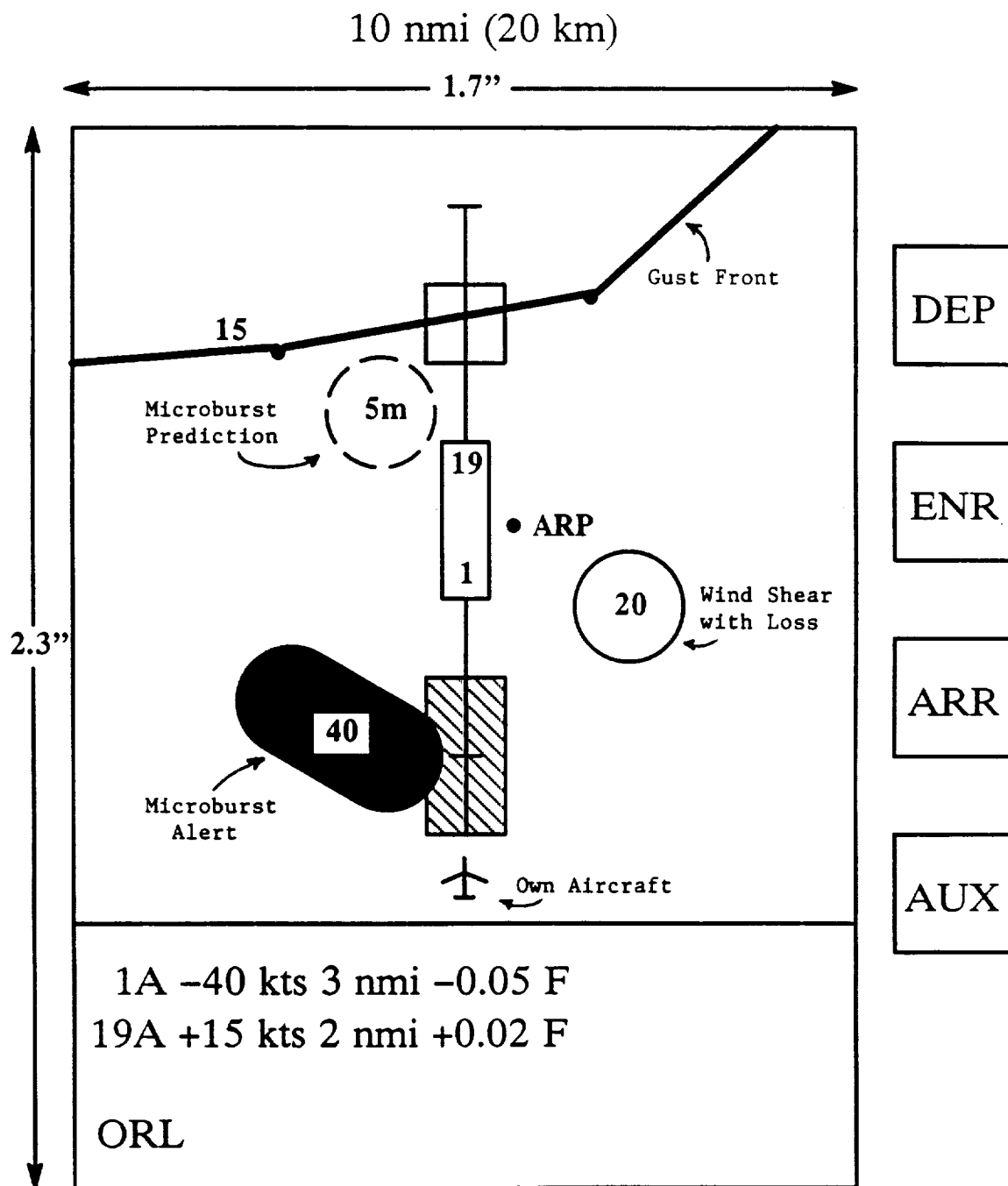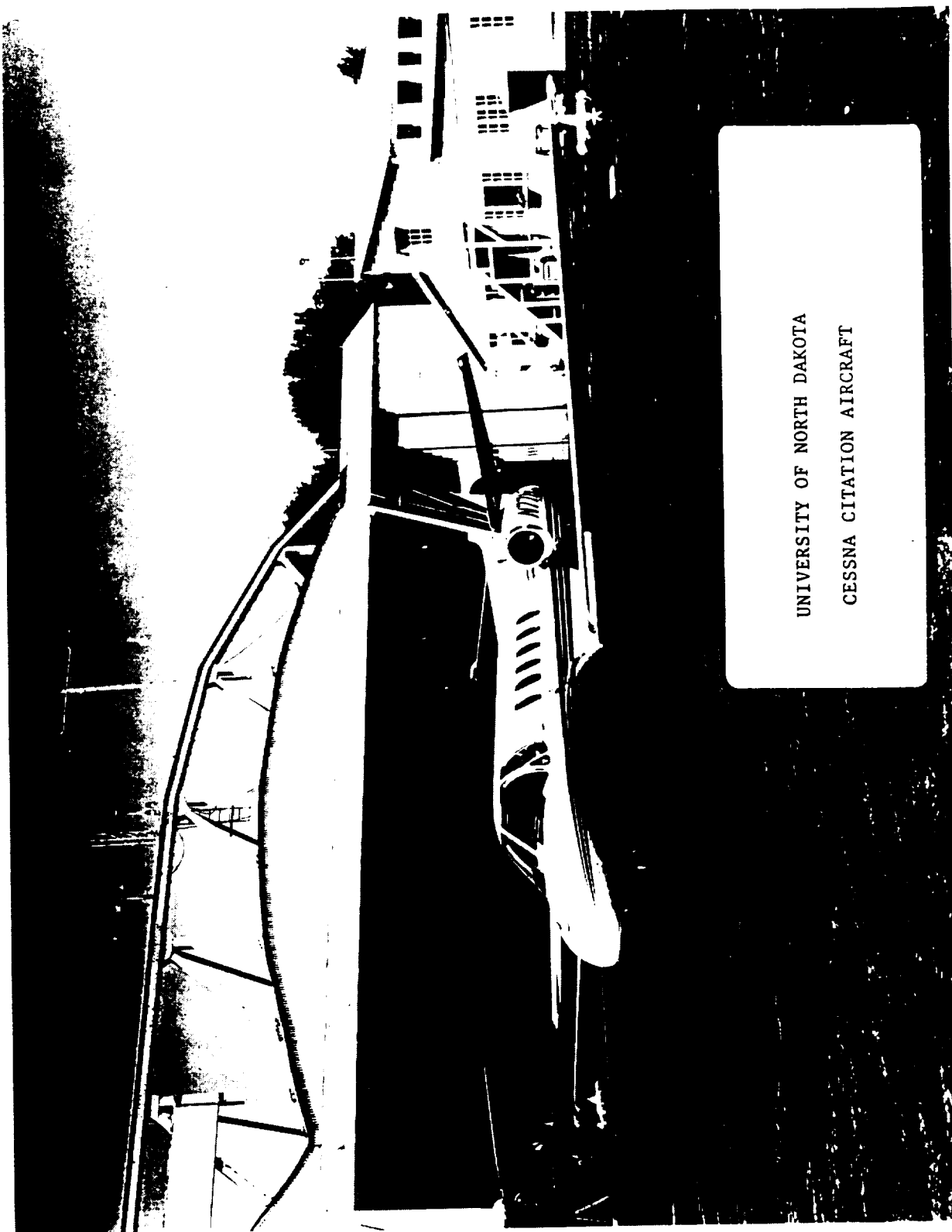1A −40 kts 3 nmi −0.05 F
19A +15 kts 2 nmi +0.02 F

ORL
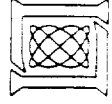
2.3"

Figure 1. Cockpit wind shear display layout
(Arrival mode)
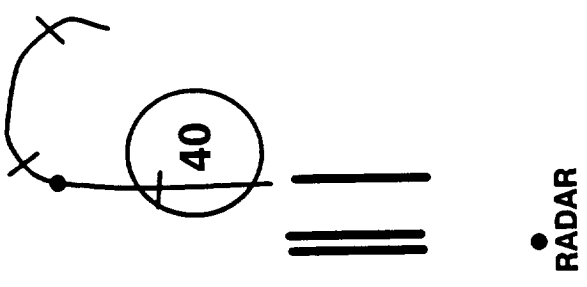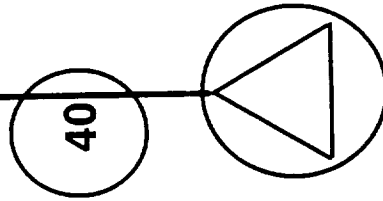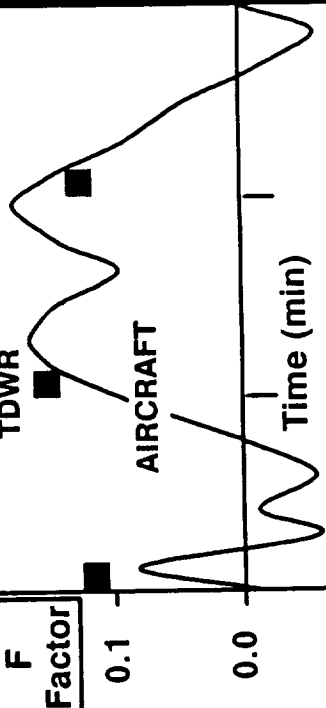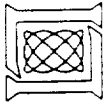
UNIVERSITY OF NORTH DAKOTA
CESSNA CITATION AIRCRAFT

255
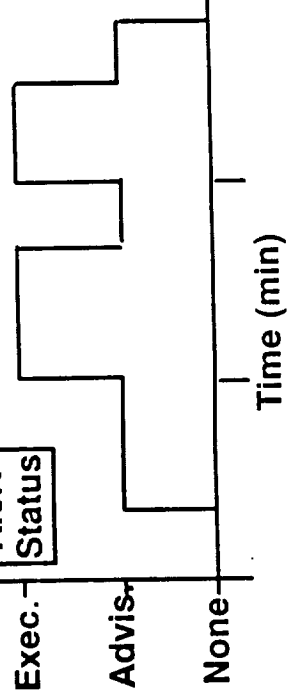
FLIGHT OPERATIONS

- 24 FLIGHTS (JUNE–JULY, SEP) BY UND AIRCRAFT

- 64 MICROBURST PENETRATIONS (W/ RADAR COVERAGE)

- DATA GATHERED:
  - CITATION AIRCRAFT DATA
  - INFRARED SYSTEM DATA (TPS)
  - TESTBED RADAR DATA AND ALGORITHM RESULTS

- ANALYSIS SOFTWARE IN PROGRESS

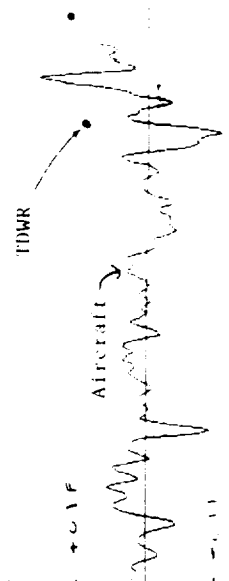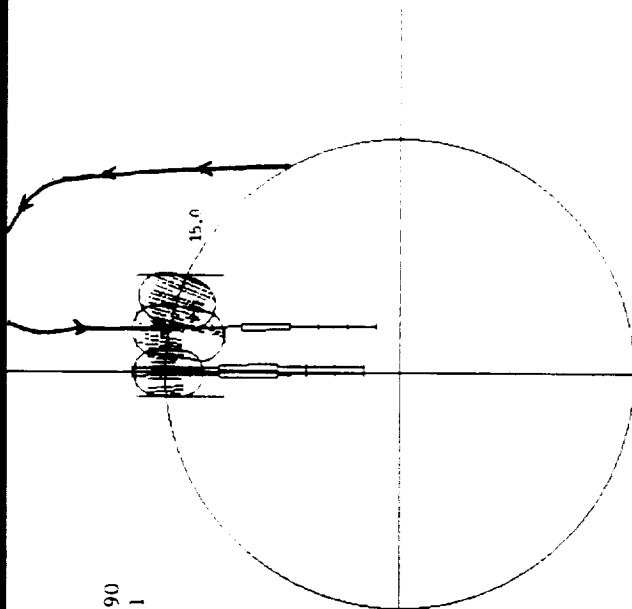# ANALYSIS WORKSTATION

Products: Aircraft Infrared TDWR

Date: 7 July 90 Orlando, FL

Start Time: 18:50:00 Current time: 18:56:00

Stop Time: 19:10:00 Step Menu Exit

AIRPORT DISPLAY

40

RADAR

PILOT DISPLAY

40

TDWR

F Factor

0.1

0.0

TDWR

AIRCRAFT

Time (min)

Alert Status

Exec.

Advis.

None

Time (min)

257

7 JULY 90
PASS #1

15.0

TDWR

Aircraft

7 JULY 90
PASS #3
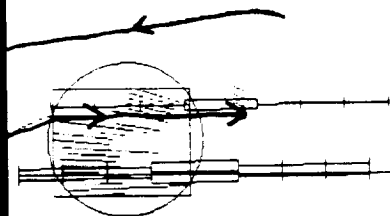
07/07/90 19:10:36
07/07/90 19:10:37
07/07/90 19:10:38
Ast refresh mode: 1
07/07/90 19:10:39

MB Tilt: 7 Jul 90 19:10:50
Site: Orlando
Elevation: 0.4000
MB_shape
MB_alarms
MB_segments
MBS_Segment_Grps
B_____
Litation:

+ 0.1 F

Aircraft

TDWR

− 0.1 F
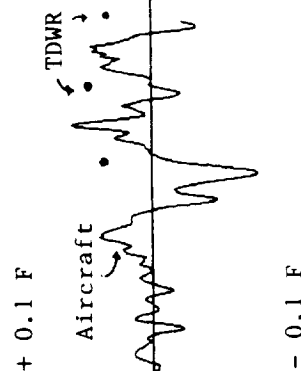
FY '90 ACCOMPLISHMENTS

- COCKPIT DISPLAY OF TDWR WIND SHEAR PRODUCTS

- AIRCRAFT PENETRATIONS OF MICROBURSTS

- ANALYSIS SOFTWARE DEVELOPMENT
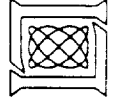
FY '91 PLANS

- ORLANDO '91 OPERATIONS

- F FACTOR ANALYSIS FOR CITATION FLIGHTS

- CREW WARNING PROCEDURE IMPLEMENTATION

- NASA 737 AIRCRAFT SUPPORT

Orlando Experiment - Questions and Answers

Q: ED LOCKE (Thermo Electron Technologies) - What is the cost per airport of the TDWR as projected by Raetheon? How effective is the TDWR in seeing dry microbursts?

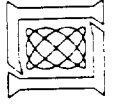A: STEVE CAMPBELL (MIT Lincoln Laboratory) - I don't have the exact numbers here but I believe the total cost per airport is something on the order of 6 to 7 million dollars. On the other question; our feeling is that the TDWR is very effective in detecting dry microbursts. About the lowest reflectivity you're going to see in an outflow, even in Denver, is down in the order of -20 to -10 dBZ. That is well within the sensitivity rating of the TDWR. For the ASR9 with the wind shear processing you do have a sensitivity problem in a Denver type environment.

Q: NORMAN CRABILL (Aero Space Consultants) - Have you considered uplinking the microburst velocity divided by distance or the Bowles' F-factor to the pilot?

A: STEVE CAMPBELL (MIT Lincoln Laboratory) - We in fact did transmit that to the airplane but we didn't display it. We could have and perhaps should have. It was an operational decision.

Q: ED LOCKE (Thermo Electron Technologies) - Can you give the characteristics of the TDWR used in the tests at Orlando?

A: STEVE CAMPBELL (MIT Lincoln Laboratory) - I'll give you the characteristics for the TDWR as I recall them and our test bed is very similar to these characteristics. The wave length is 5 cm; the antenna diameter is 27 feet; the PRF is adaptive. We have an adaptive scheme where we scan at a low PRF of about 350 Htz. That allows us to identify unambiguously the very long range echoes. We then adaptively select a PRF which minimizes second trip folding into the first trip. In particular we try to minimize the folding around the immediate airport region. If there is folding that we can detect it, since we know unambiguously where all the range echoes are, we can determine from a given PRF where all the folding is occurring and flag the obscured cells. As a practical matter our PRF goes from something on the order of 700 Htz up to about 1200 Htz. The pulse energy of the Raetheon TDWR is a quarter of a gigawatt and the pulse length is one microsecond. Our pulse length make be a little bit shorter for technical reasons. The microburst alarms are updated once a minute. Our beam width, both horizontal and vertical is a half degree, actually TDWR is 0.55 degrees.